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# East Europe Report

## ECONOMIC AND INDUSTRIAL AFFAIRS

(FOUO 6/82)

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## CONTENTS



 [III - EE - 64 FOUO]

CZECHOSLOVAKIA

INDUSTRIAL ROBOTIZATION IN CSSR OUTLINED

Prague TECHNICKY TYDENNIK in Czech 27 Apr 82 pp 10-11

[Article by Eng Milos Fibiger and associates: "What Next in the Development of Industrial Robots"; portions within slantlines in Bold Face]

[Text] Intensive development of electronics and particularly microelectronics, experience gained so far with computerization of industrial production, all this makes it possible to get closer to the goal of utilizing computerized means of production in three shifts, in which service is required only during the first shift and at the most also in the second shift. That brings about penetrating rationalization and at the same time releases working people from heavy and monotonous work which is harmful to health. Industrial robots and manipulators in particular need to be utilized for flexible computerization of production processes.

Great attention is being paid now in industrially advanced states to industrial robots and manipulators. Their manufacture is registering the highest growth in this decade. The development is advancing rapidly from simple manipulators through robots with program control to robots now using elements of synthetic intelligence.

Several hundreds of various types of industrial robots and manipulators are now in operation in the world, ranging from the smallest types all the way to robots capable of manipulating loads weighing several hundred kilograms. Now, industrial robots and manipulators are used routinely in welding, machining, forming, surface treatment, thermal processing, installation work, and they also appear in almost all branches but mechanical engineering. At the congresses of communist parties held last year in the majority of the socialist states, the development of computerization and robotization was included in the strategic goals of future development and effective measures were adopted to provide for it. This was the case especially in the USSR, where the CPSU dealt with the development of industrial robots and manipulators at its session in August 1980. In the GDR, the congress gave instructions to introduce 40,000 to 45,000 robots by 1985, and in the Bulgarian People's Republic the development of robotization was categorized as the party's second principal strategic goal in industry.

Resolution of the CSSR Government

The CSSR Government has also included the development of industrial robots and manipulators in selected target programs of the state, and its resolutions are designed to bring about a coordinated advance in the entire national economy. However, that requires an urgent creative approach of all components in industry and in the organizations of the National Front, and an effort on their part to seek the most effective ways of utilizing and developing this new technology in the computerization of production.

In order to provide for the maximum creative approach of all components and organizations to the elaboration of the concept of development of production computerization involving the use of robots and manipulators, we present a survey of measures adopted so far and examples of the procedure used in the preparation of the concepts and programs in all suitable branches, fields and technologies of the national economy. Information about the share of the branch offices and organs of the CSVTS [Czechoslovak Scientific and Technological Society] in the robotization program is given elsewhere in the ZPRAVODAJ (Reporter) of the CCSVTS Czech Council.

The Presidium of the CSSR Government, acting at its session on 12 October 1981, adopted resolution No 211/81, and in January 1982 the CSR and SSR governments adopted resolution No 6/82 on the concept of the development of industrial robots and manipulators.

In these resolutions, the appropriate ministers are instructed to provide for the necessary production of industrial robots and manipulators, components. investment units and so on. Instructions are given to federal ministers of general engineering, metallurgy and heavy engineering, electrotechnical industry, fuels and power, transportation, technical and investment development, and also to ministers of industry, agriculture and nutrition, construction, health, construction development and technology of the CSR and SSR to work out in their jurisdictions the program and utilization of industrial robots and manipulators in the Seventh Five-Year Plan, the goal being to expand the program especially in the following periods. Opportunities for their own manufacture of robot accessories are to be evaluated at the same time. Cooperation is to be utilized in the process with the central, Czech, and Slovak councils of the CSVTS.

/The basic goal of the program is to produce and put into operation by 1985 more than 3,000 robots and manipulators, and save the services of 5,500 production workers, and by 1990 to put into operation 13,000 robots and manipulators in machine building as well as other technologies./ The program instructs the

Federal Ministry of General Engineering to build 920 computerized technological work centers using robots and manipulators to simplify the terminology, we use abbreviations in the following text: ATP / [for Computerized Technological Work Centers] and PRaM [for Robots and Manipulators],/460 of them in metallurgy and heavy engineering and 125 in the electrotechnical industry. The rest in other departments under federal and national ministries.

Organization of the Program

The Federal Ministry of General Engineering is the program coordinator. The Metal Industry Research Institute (VUKOV) in Presov holds the function of the commissioned organ. The institute is also entrusted with marketing coordination, import coordination, and coordination of production field 479, namely, Industrial Robots and Manipulators (PRaM).

In the departments of general engineering, metallurgy and heavy engineering, and electrotechnical engineering, guarantors for the program or robotization were designated, and workers responsible for the program were named in individual economic production units [VHJ]. Their assignment is to act jointly with enterprises and provide for the use of the planned number of robots and manipulators. Each VHJ works out the program for the establishment of ATP with PRaM, which is an obligatory document for all the managed enterprises. All VHJ of the department of general engineering have now completed the preparation of this document. An organization of guarantors has also been selected for the preparation of the program in other departments. Guarantors have been or are being nominated in ministries, general directorates, enterprises and manufacturing establishments. Also, most ministries and economic production organizations have designated organizations of the type of technological and project institutes and manufacturing establishments to provide assistance in the preparation of individual proposals and a comprehensive program for the entire organization.

/However, most of the ministries are only beginning to organize the work on the program. Therefore, we mention as an example the procedure selected by the CSR Ministry of Industry. This is the most rational procedure for the initial stage of the work./

Workers in manufacturing establishment can have the best ideas about what could be and would have to be computerized in the future and how PRaM could be utilized in the process. They are familiar with their base and their production program, they know which workplaces are difficult, harmful to health and monotonous, or where it would be purposeful to use production means in three shifts. Such workplaces exist not only in the departments of these ministries which have been assigned the task, but also in other branches of the national economy. By providing this information, we also want to give them an opportunity to take part in the exploration and expand the program to include their production processes, too.

It is obvious that in many cases computerization will require mechanisms which will be entirely different from the robots and manipulators manufactured today, but the goal of this drive is also to formulate such requirements in specific terms.

This should lead to a program which, if improved continuously each year, of course, will make it possible not only to formulate specifically the requirements with regard to our industry, but also to set up a program in the entire CEMA. Similar drives are being conducted also in other CEMA countries. The program will create prequisites for the necessary standardization and unification of robots and manipulators, particularly sectional modules and components for robotized workplaces, and arrangements for their specialized production in appropriate cooperation of the CEMA countries.

Procedure in the CSR Ministry of Industry

VHJ of the CSR Ministry of Industry, acting in cooperation with the appropriate specialized institutes, expert organs of the CSVTS and VUKOV in Presov, are organizing in April briefing programs for guarantors and representatives of branch offices of the CSVTS. Depending on the needs, they are also forming suitable teams to deal with the problems. They also transmit to them the form and examples showing how to proceed with the research work.

The VUTESP [?Research Institute of Heavy Machine Building Industry] in Prague, a leading work center for scientific technical development in the area of manipulation of material, storage, and containerization, acting in cooperation with the organizations PIKAZ in Prague and VUKOV in Presov, has worked out the primary basic material (methodology, forms, and examples).

Those who are interested in this material can request it from their guarantors in the ministries, from the authors, or from the secretariat of the PRaM work groups attached to the Czech Council of the CSVTS. The material will become available gradually also in consulting and advisory centers of the CSVTS technology buildings in all krajs.

The material used for determining the possibility of introducing ATP centers consists of two parts: the title paper and three tables for basic technical economic purchase order (ZTEZ).

The title paper serves for orientation about the degree to which the preparatory work has been worked out and for the establishment of ATP. The executive organ (a unit of the given enterprise or an external supplier) and the time schedule for the initiation and completion of the activity are indicated for each stage. Six stages are recommended for the preparation and implementation of the entire drive (project preparation of the ZTEZ; production documentation; modernization of the production technical base; implementation; testing and delivery), and 22 sectional stages such as preparation of the ZTP [?Heavy Machine Building] programs, project assignment, single-stage introductory project, executive project, etc.

The ZTEZ is filled out for each technological work center which can be computerized not only by the PRaM listed in the existing program, but also by the equipment developed and manufactured in the production facilities of the VHJ themselves or by the enterprise, etc.

It contains basic characteristics concerning the technical problems of the program, the manipulated object or material, environment, nature of the work, number of workers, and so on, specification of peripheral systems, cost limits; the required target parameters (production of the workplace, operational time, time synchronization, operating hours, time utilization, time for control switch, etc., planned target date, expected economic results), additional reasons for the establishment of an ATP, possibility of repeated construction within the manufacturing establishment, commentary, opinion of the specialized professional work center of the VHJs, and opinion of the organizations as to whether the selected technological work center is feasible and suitable for computerization.

The ministry has instructed the enterprises to complete the research work listed on the required standard form by 30 May 1982, to process the set according to the technologies for individual VHJs by 15 June 1982, and to deliver all the basic data to the departmental Technical Economic Research Institute of the Consumer Goods Industry, which has been given the task of further processing of the work. During the month of July, the institute is to evaluate the proposals of the technical economic assignments and formulate them more specifically in August jointly with the VUKOV, the VHJs, and the enterprises. The prepared program of installation of robots and manipulators for the departments under the CSR Ministry of Industry is to be delivered then to the federal ministries of technical and investment development and general engineering for complex processing of the program for the CSSR by 30 August 1982.

/Why is it necessary to work out by 30 August 1982 the draft program for individual branches, ministries as well as for the CSSR national economy? It is necessary first of all because according to the uniform methodology which has been approved currently in CEMA, the program has to be delivered to the appropriate CEMA organ. Then, by the end of the year, a proposal is to be prepared concerning the most appropriate modular systems of robots and manipulators in CEMA and the necessary measures for concentrating the production facilities for their designing and manufacture./

Furthermore, in order to work out the concept of computerization of the production processes involving the use of robots and manipulators in the CSSR, it is necessary in particular to give more detailed specifications concerning the required assortment of robots, manipulators and peripheral equipment, their quantities and the provisions for production facilities, including international cooperations, exports and imports, entitlements with regard to components both in terms of quality and quantity, existing or new tasks of technical development, international cooperation in research, development, and also demands as to how to gain experience in installing and operating computerized work centers involving the use of robots, the necessary investment, foreign exchange, etc., the number of project designers, programmers, operational technicians and maintenance workers in computerized work centers using robots and manipulators, the number, scope, and specialization of the necessary short-term training courses, postmaturity extension courses and postgraduate studies, and so on.

Tasks for Our Organizations

/Additional information indicates that because of the short time limits much depends on the coordination, initiative and creative approach of the individual organizations. Indeed, that is the only way to achieve effective results./

A study called "Methodology for The Formulation of Technologically Justified Technical Requirements for Industrial Robots and for Determination of Their Orientational Requirements up to 1995" was approved in March 1982 at the 25th Session of the CEMA Committee for Scientific-Technical Cooperation.

This methodology contains a list of parameters and a method of their determination. At the same time, these parameters are divided into two basic groups: classification parameters, which determine the type of an industrial robot, and parameters determining the technical level of an industrial robot of any type.

The classification parameters include in particular the type of propulsion, loading capacity, method of control, degree of adaptation, type of kinematics, and certain other supplementary characteristics (mobile or stationary, and so on).

The parameters determining the technical level of an industrial robot include, among others, the number of the leeway degrees, operating speed, accuracy of positioning, memory capacity, number of connections with external equipment, and certain additional supplementary characteristics (reliability, programming method, etc.).

The need for industrial robots is to be determined according to the given methodology as follows:

--/by determining the required types of industrial robots/ on the basis of an analysis of the work centers from the viewpoint of the possibility of computerizing them by means of industrial robots;

--/by determining the number of industrial robots/ needed for computerization of the production processes under consideration. The prognosis is made on the basis of the rate of speed (level) of robotization determined a priori, and at the same time the level of robotization is determined as the ratio of the number of robotized installations or robotized work centers and their total number in the given field (in the given type of production). At the same time, the actual economic and technical opportunities are taken in consideration for each planned period;

--/the effectiveness of installing/ industrial robots is evaluated by indicating the number of manual workers released and the nature of their work (of the given operation) from the viewpoint of the danger of accidents, physical stress, monotony, etc.

The following tasks ensue for 1982 /from the measures taken by CEMA for all member countries, and therefore also for the CSSR/:

--/providing the CEMA Secretariat with information about the construction/ of industrial robots designed for various purposes, which exist in individual member countries of CEMA, and about the concept of technical development of robot technology in these CEMA member countries (up to the end of March 1982), on the basis of which a uniform concept of technical development of robotization will be completed in CEMA member countries (by June 1982). The first version of this concept, based on a consistently modulated principle of the construction of industrial robots, has already been submitted for discussion at the 25th Session of the CEMA Committee for Scientific-Technical Cooperation;

--determining in the appropriate branch permanent committees of CEMA the /technologically justified technical requirements/ in terms of industrial robots for the given branch on the basis of approved methodology (by the end of the third quarter of 1982);

--/approving technical requirements/ concerning unified joints and parts of industrial robots, and preparing technical recommendations for unification of parameters and areas of their application (at a conference of experts of CEMA member countries in November 1982).

All these operations are to be carried out in individual CEMA member countries under the direction of the appropriate central organs for science and technology.

At the 25th Session of the CEMA Committee for Scientific-Technical Cooperation (held in March 1982), there was also approved the text of an intergovernmental Framework Agreement on Multilateral Cooperation in the Area of Development and Organization of Specialized and Cooperative Production of Industrial Robots, which is to be signed at the next, 36th, session of the CEMA Council. A Council of Chief Construction Engineers and a Coordinating Center are to be set up on the basis of this agreement.

The Content of the Robotization Program

The processing of the program, which is based mostly on the implementation and evaluation of the research work, is merely the first stage. The prerequisite for determining whether the selected designs of robotization are appropriate is to evaluate thoroughly their technical economic handling. This is done by using a well-tested and currently used methodology, according to which we proceed as follows;

/first stage/--preparation of an exploratory technical economic questionnaire (it is just being prepared and will be routinely supplemented);

/second stage/--elaboration of a technical economic design (this has been done so far only for a few hundred of drives);

/third stage/--preparation of a project of a computerized technological work center with robots and manipulators (this has been done only in a few dozens of designs);

/fourth stage/--manufacture of equipment which is lacking for computerized technological work centers with PRaM;

/fifth stage/--construction of the work center (installation work, putting it in action, test running, formal delivery for routine operation).

By evaluating the completed research questionnaire, one can determine with an accuracy of about 80 percent whether the work center is suitable for computerization. This result is also expected from an evaluation of the proposals in July 1982.

The role of the second stage is mainly to document the suitability of the technical and economic design of the work center, including the need for a structural development of the peripheral equipment, the conditions for labor safety, and so on. We proceed with the executory project only after the contest procedure has resulted in a go-ahead decision.

We put emphasis on this activity, because it is unavoidable in building ATP and PRaM. Experience gained so far shows that the construction and project preparation of a work center takes 1 to 2 years depending on the complexity of the elements used in the ATP and in the necessary peripheral equipment. It means that preparatory work has to start as early as by the end of 1982 in the case of work centers which are to be built starting in 1984. This does not apply to cases where manually operated manipulators are used, cases when the manipulators are part of the production technology, or when it is a question of repeated standard application.

/The following procedure is recommended for a smooth and systematic dislocation of PRaM and construction of ATP with PRaM/:

1. VUKOV in Presov with its facilities provided for coordinating engineering and project activities to satisfy the needs of enterprises under the jurisdiction of the federal ministries of general engineering, metallurgy and heavy engineering, electrotechnical industry, CSR and SSR ministries of industry, and also of other departments. VUKOV is entrusted at the same time with marketing coordination and import coordination.

In the area of marketing coordination, it provides mainly for reception, recording, and balance accounting of requirements of the users and for the allocation of these requirements among the manufacturers. It provides for similar activities in coordinating imports of specialized technology. This means that any requirements by the users must be submitted to VUKOV in Presov, which assigns the requests to individual manufacturers, if the requirements concern PRaM manufactured in the CSSR, which are kept in records under the program. The situation is similar with regard to claims for imported PRaM. VUKOV evaluates in such cases the actual situation at the given work center and its claim for the required imports, and then acts as an intermediary in dealing with the appropriate foreign trade enterprise.

2. Project organizations of the type of INPRO, PIKAZ, UTAR [Institute of Technology and Rationalization], URA, Prago Union Institute for Rationalization, or technological institutes (even departmental ones) must gradually build project facilities to provide for the needs of their own VHJs or special technologies. Certain ministries other than engineering industries, which so far did not start the preparatory work and found it difficult to determine an organization for work on the program, face a particularly significant task in that respect. VUKOV in Presov should keep dealing more and more with typical, standardized work centers and help in solving collective problems.

3. Centrally managed project organizations of the types such as Kovoprojekty (Metal Projects), Projekty (Projects), Hutni Projekt (Metallurgical Project), Keramoprojekt (Ceramics Project), Uniprojekt, and so on, must provide for robotization mainly in projects of new investment construction development. Departmental expertize units will not accept as of 1983 any project which does not deal with computerized work centers involving the use of PRaM in three-shift operations.

4. Organizations manufacturing PRaM are to gradually create units for engineering technical activities, which will take care of installing PRaM manufactured by these organizations, mainly in repeated typical and standardized work centers.

It should be emphasized that each of the given organizations face very important tasks in the field of PRaM. It is so especially because in the field of robotization the development advances rapidly in all industrial states, innovations of robots and manipulators follow one after the other, and as a result of the introduction of adaptive robots by the end of the current five-year plan the opportunities for utilizing robots for flexible computerization of the production processes will be expanded considerably.

What Can We Count On?

On the basis of the program for the Seventh Five-Year Plan dealing with repeated introduction of robots and manipulators in computerized technological work centers, we can consider above all the use of robots and manipulators which have been developed up to 1981. This applies mainly to the following types: /industrial robot PR 04, industrial manipulator M 04, industrial robot PR 16, industrial robot PR 32, manipulation system M 63, industrial manipulator MTL 06, industrial manipulator M 63 OH, universal manipulator UM 160, industrial manipulator MZL 10, automatic manipulator AM 5, industrial manipulator PROB 10, industrial robot and manipulator PRAM 01, industrial robot and manipulator PRAM 02, sectional manipulator M 1, horizontal setting unit MX001K8A, single-drive setting units, manual manipulators RMS 35 and manual manipulators PMS/ (we shall publish a description and pictures of some of these pieces of equipment in the next issue).

With regard to the program for the Eighth Five-Year Plan, the research task called "Adaptive Industrial Robots and Manipulators in 1981 to 1985" deals with additional types of unified manipulators and adaptive robots: the AM 1 computerized manipulator, designed for servicing forming machines and construction of computerized production lines; M 40 manipulator with a loading capacity of 40 kilograms, designed for manipulation of sheet metal used particularly for surface forming; the AM 80 computerized manipulation system with a loading capacity of up to 80 kilograms, used for special purposes of servicing machine tools, point welding, electrothermal installations, etc.; the APR 2.5 adaptive industrial robot with a loading capacity of 2.5 kilograms, designed for complex spatial manipulation and installation; the APR 40 adaptive industrial, used for complex spatial manipulation and point welding; the SPR 10 spraying industrial robot, designed for computerization of surface treatment technologies.

Part of the development work also consists of the development of interoperational transportation of the type of pitching conveyor belts with a loading capacity of 500 kilograms, and of computerized suspension rails with a loading capacity of up to 250 kilograms. Other equipment which is being developed includes accessories such as large-capacity magazines, position finders, strippers, etc., including technological chucks and grippers.

/All the given robots, manipulators, and pieces of equipment are manufactured repeatedly or are being prepared for production in the following organization/:

--Industrial Automation Works in Presov, which is one of the key manufacturing establishments. The production of PRaM based on pneumatic elements is concentrated there;

--Vihorlat in Snina, which concentrates the manufacture of M 63, UM 160, MTL 10 manipulators with hydraulic control and the construction of ATP and PRaM for pressure casting;

--VUKOV in Presov, which is oriented to the manufacture of test series of PRaM from their own development program (still including in 1982 PR 16, PR 4, PR 32, and M 63), and also to be production of atypical equipment for interoperational and operational manipulation used for the construction of ATP and PRaM;

--ZTS [?Heavy Machine Building Works] Detva, which manufactures PR 32, complete robotized welding work centers with PR 32 for electric arc welding, and also computerized and mechanized welding work centers, including peripheral equipment;

--ZTS manufacturing establishment in Bardejov, which manufactures M 63 in relation to the existing manufacture of hydraulic components;

--TOS Trencin, which has been designated as the manufacturer of the M 63 special-purpose modified manipulation systems for machine tools from the production program of the VHJ TST [Engineering Machinery Works];

--BAZ [Automobile Works] in Bratislava, which manufactures PRaM and JUS [expansion unknown] of the VHJ CAS;

--SAM in Myjava, which will manufacture industrial robots for surface treatment;

--ZEZ manufacturing establishment in Horice, where the production will concentrate on building complete robotized welding centers equipped with PR 32;

--Skoda manufacturing establishment in Ostrov on the Ohre River, which manufactures pneumatic manual manipulators with a loading capacity of up to 250 kilograms;

--Strojsmalt in Medzev, which manufactures standard equipment for operational and interoperational manipulation designed for the construction of ATP with PRaM;

--Czech Motorcycle Works in Strakonice, which is preparing production of PROB 10.

It is self-evident that everything has not been provided for as yet for the production in every manufacturing establishment listed above, either from the quantitative viewpoint or especially from the qualitative viewpoint. In order to reach the necessary level, not only the control organs and management of the organizations but all workers will have to develop considerable efforts.

Furthermore, one should emphasize again that the users themselves will have to manufacture for their own use especially certain special pieces of equipment and peripheral equipment to complete the entire computerized technological work centers with PRaM. At the same time, they have to take advantage of the methods of approach and experience of the combines and enterprises in countries, such as, for example, the GDR, but also elsewhere where robotization of industry is advancing relatively faster than in our country.

FIGURE APPENDIX
(Only Captions Given)

Note: Pictures and descriptions of some of our other robots and manipulators will be published in the next issue of TECHNICKE NOVINY.

Figure 1. The PR 32 E INDUSTRIAL ROBOT is designed for automatic servicing of production machinery and equipment and for the area of electric arc welding and resistance welding. The control system RS 3 consists of any SM 50/40 microcomputer, which together with the regulatory power supply and safety circuits is built in a closed metal control box with forced air circulation and an IP 43 stage cover. The industrial robot may be connected through the control system with machinery and equipment which it is servicing and with cooperating machinery and equipment, thus creating a computerized work center and production systems. The nominal manipulation weight is 32 kilograms, but when the speed and acceleration parameters are reduced, it may be as much as 63 kilograms. The accuracy of positioning of the terminal element "e" is $\pm$ 0.5 millimeter.

Figure 2. The PR 16 INDUSTRIAL ROBOT is an installation which can be programmed for automatic manipulation of objects weighing up to 16 kilograms. The basic design is a sectional construction with pneumatic drives and point control (PTP) and has a punch-type measuring system. It operates in cylindrical coordinates with three clearance levels of the arm and two clearance levels of the wrist. It is designed for automatic servicing of production machinery and equipment. The robot's control system makes it possible to connect it with the serviced machinery and auxiliary equipment of the computerized technological work centers. A vertical unit is attached to a stand which can be fastened to the floor or attached to a mobile platform crane. The industrial robot can be controlled manually or automatically. Manual control is designed above all for adjustments of operating positions in individual coordinates. Automatic control is performed by the control system of the RS 2 with the central unit NS 910. The accuracy of positioning is $\pm$ 0.2 millimeter. The application of the system has been tested now on many technological systems. A PR 16 robot operates in the ATP used to control transformers at the ZVS [General Engineering Plant] in Dubnica on the Vah River; in the ATP for grinding the

rings of bearings of railroad cars at the ZVL in Dysucke Nove Mesto; ATP for pressure casting of metals at Kovolit in Modrice; ATP for machining of non-rotating flange parts at the Jihlavan National Enterprise in Jihlava; ATP for pressure casting at the AZNP [Automobile Works, National Enterprise] in Mlada Boleslav; module work center with two machine tools SPL 25 NC at the UTAR in Bratislava, and other places.

Figure 3. Manual Manipulator on the RMS-20 stand is designed for manipulation of loads weighing up to 20 kilograms. It has been developed and is manufactured by VUKOV in Presov. The establishment is also manufacturing versions of this manipulator with higher loading capacities of up to 35, 63, 200 and 250 kilograms. The manipulator has a hydraulic or electrohydraulic drive. These types of manipulators are called balancers, because when they have been balanced they can move loads by using a very small amount of power. Their use eliminates investments in building crane rails and installing the crane. Balancers are also built as mobile, depending on the requirements. They are also used in branches other than those of the machine building industry, for example at the Strojplast in Trnava for manipulation of heavy reels of glass fibers. Similar balancers with pneumatic drive are also manufactured by the Skoda works at Ostrov on the Ohre River. They are types PMS 110 and 180, and PMZ 110, 180, and 250.

Figure 4. AUTOMATIC MANIPULATOR AM 5 of the standard design consists of a two-arm manipulator with a loading capacity of 2.5 kilograms on each arm for the technology of surface and volume forming. It is most suitable for use with presses using pressures of 6.3 to 16 MPa. It can be modified for special purposes by adding a third arm. Depending on the shape of the manipulated object, the manipulator is equipped with electromagnetic suctions or magnetic tentacles, or combinations thereof. It is controlled by a computer NS 910 which can be programmed or by an UCM 663 pneumatic system. The engine part of both control systems can remain designed in the same way. The drive of all axes is pneumatic, the accuracy of positioning is ± 0.1 milligram. The manipulator is the result of joint research by VUKOV in Presov and ENIKMASH in Voronezh.

Figure 5. The M 63 OH INDUSTRIAL MANIPULATOR is designed for automatic exchange of semifinished shafts and workpieces between the clamp of the machine tool and the readying conveyor belt or the feeding equipment. It is suitable for inclusion in automatic production lines with various types of machine tools which have an automatic operating cycle, with a horizontal axis of machining, and which provide for vertical input in the operating area of the machine. If an adjusted or specially developed double tentacle is used, one can use the manipulator for operational manipulation of flange parts or non-rotating parts of even greater weight. An additional unit containing tentacles can be attached to the rotating unit of the arm, when manipulating parts of long shafts. The accuracy of positioning is ± 0.5 millimeters, the method of

measurement is of the punch type, the control used is the PTP, the RS 1 and RS 2 control system, the programming is manual. The length of the lift of the sliding support unit can be used within the range of 2,000 to 8,000 millimeters scaled at 1,000 millimeters.

Figure 6. INDUSTRIAL MANIPULATOR MTL 06 WITH TENTACLE, of standard design, is built for automatic manipulation of objects weighing up to 40 kilograms. It is also suitable for operational manipulation of hot castings under conditions of pressure casting of nonferrous metals. It provides for automatic servicing of production machinery, and makes it possible to interconnect the control systems of machines and the control of auxiliary equipment of technological work centers. It is able to change at will the programming of the sequence of the controlled movements. It makes it possible to exchange the clamping jaws and tentacles, depending on the shape of the manipulated object. The MTL 06 manipulator is assembled from sectional junctions and units of the M 63 manipulation system. The drives of the manipulator are hydraulic, with electric controls. A fluid which is not easily flammable is used as the driving medium for safety reasons, because the manipulator is used in plants with increased operational temperature. The accuracy of positioning of the tentacle is ± 0.5 millimeter. The method of measuring is of the punch type, control of the PTP type. The control system used is the RS 2 with an NS 910 computer which can be programmed.



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NEED FOR MORE ELECTRONICS IN MACHINE TOOLS STRESSED

Prague TECHNICKY TYDENNIK in Czech 11 May 82 p 3

[Article by Eng. Bedrich Chodera: "What Are the Needs of Our Machine Industry"]

[Text] There is no industrial sector that has been talked about more lately than electronics and microelectronics. It is a generally accepted fact that if the situation in our industry, and particularly in the machining industry, is to improve, it will depend, among other factors, on the contributions by electronics, and only then on those of other finishing sectors. After all the electronic equipment of machine tools of leading world producers sometimes constitutes today the major part of their price and is the determining factor of their technical level.

And in our country? Will we succeed in reducing the lag in the coming years? The new Federal Ministry of the Electronic Industry very correctly emphasizes creation of a parts base with an adequate lead and at a level enabling us to equip our machinery with control equipment that would not overly lag behind the top world standard. However, that calls for devoting considerable resources, investments, and capacities to this task.

The Past and the Present

Machine tools without electronic controls are today virtually unmarketable. As this involves of traditional products which, moreover, to this time formed a significant part of our exports, we set out in this direction also in our country. How did it all actually start? We discussed it with the deputy manager for development in Tesla Kolin, Eng. Jindrich Hlubocky, who familiarized us with the past, present and envisioned future of this interesting sector in our country.

Already prior to 1970 there originated in the Research Institute for Machine Tools and Machining in Prague a group for electronics which outlined the prospects of its development for producers and for users alike. It also coordinated, and still coordinates, the intentions of all our producers including any developmental effort. An even larger group of development specialists in electronics devoted their efforts to this sector at the Research Institute for Communications Technology of A. S. Popov in Prague.

As a result, in the early 1970's, the CSSR devised control systems with germanium transistors which are now referred to as 1st generation systems. Then came the 2nd generation with silicon transistors and the 3rd with integrated circuits of low integration. For all practical purposes, these systems are being produced to this day, because our parts base until recently did not offer any other possibilities. Typical representatives of these systems are, the NS 471, NS 351, NS 361, systems, etc., from Tesla Kolin which in the past years turned out many different types, often custom made, for our machine tools. Another producer of this technology in our country became ZPA [Plants for Industrial Automation] in Kosire.

The concept that an electronic control system is a metal box, full of wires, parts and circuits which is simply attached and connected to a machine, is greatly misleading. It definitely does not involve more replacement of manual control with program commands from a perforated tape. An electronic control system can accomplish much more: it can render machining more accurate and, as a result, improve the quality of products; it can increase labor productivity, introduce diagnostics, and compensate for the effects of tool wear, etc.

Contributions of Microelectronics

The existing parts base led to a relatively complicated design of electronic systems and an extremely dense network of interconnecting conductors. In addition, even the functional properties of these so-called 3rd generation systems are limited.

Improvements in the potential of electronic control systems call for transition to a higher level to microcomputer systems. The first type--Model NS 660--is already in series production. Within two years Tesla Kolin will launch serial production of additional types of CNC systems to the point that they will constitute a major part of the plant's production. They differ from previous products in their higher degree of sophistication which is provided largely by the availability of large capacity internal memory. In the latter are stored data about how a given part is to be processed and, further, mainly information regarding the properties of the machine and instructions necessary for its control. It can be said that a microcomputer with its software will actually replace a considerable part of existing systems which are many printed circuits interconnected by a complicated network of conductors.

This coltribution is very considerable, if not the only one. Modern CNC systems from Tesla Kolin can change the control program in a simpler manner, an operation that used to call for complicated manipulation with a perforated tape while operating the machine. The capacity of their memory is such that it can handle the entire technological process for the production of one or more parts. This translates into considerably improved reliability. In addition, there is a possibility for, e.g., machine tool diagnosis.

The key customers for products of Tesla Kolin are the Machine Tool Plants [TOS], e.g., the TOS Kurin (systems for milling and cutting machines), the TOS Hulin (turret lathes), the TOS Varnsdorf (horizontal boring and milling machines), the TOS Olomouc and the ZPS [Precision Machine Tools Plant] Gottwaldov (machine tool systems), etc. Cooperation with machine builders is very close and also very successful, as is borne out by the gold medal awarded to the Model SPS 25 NC automated lathe from ZPS Gottwaldov at the Brno Trade Fair and interest abroad which became manifested at the trade fair in West German Hannover.

A System Consists of Elements

They did not wait for the first microprocessors to appear on our market in Tesla Kolin. For the time being, they substituted a circuit of discreet components on three circuit borads for the microcomputer system 8080. However, it is not just a matter of having a processor and memories. A control system needs additional elements for its operation, such as sensors, which are also produced by Tesla Kolin. As a matter of fact they turn out two kinds: one for direct and one for indirect measurements. These are photoelectric sensors and inductive sensors. They turn them out in cooperation with ZPA Kosire, which promotes specialization and concentration of production.

An interesting device is also the programmable automation, another product of Tesla Kolin. It is essentially a single-purpose computer which according to instructions from memory controls functional elements of an operational machine. Nevertheless, the programmable automation is also capable of independently solving some technological processes. For instance, of great interest is application of programmable automatons NS 910, modern systems with contactless switching of functional elements, used in plating shop equipment and produced by Kovofinis in Ledec on the Sazava River. Whoever would want to see a truly modern and high-performance line for zinc and chrome plating should go to Kolin to have a look. Human hands do not come in contact with parts during electroplating.

Giving the Green Light to Advanced Technology

In Kolin they are already contemplating new generations of control systems for machine tools. They will contain the most modern elements available. For example, already in 1983 developmental specialists should have at their disposal a 16-bit microprocessor which will provide three times as many possibilities for its users as the present CNC systems.

There will also be a need for more extensive utilization of new types of semiconductor memories, integrated circuits, structural elements. Tesla Kolin has been a pioneer in introduction of new technologies, e.g., wrapped joints. In cooperation with the Research Institute for Telecommunications they developed and produced a semiautomatic winding device which considerably increased the productivity of labor, and mainly, quality and reliability. Another interesting product of theirs is also a microprocessor developmental system (MVS 800) without which microcomputer application is unthinkable and which so far nobody else is producing in the CSSR. This product is a great contribution made by Tesla Kolin to the nationwide program for electronization of our national economy.

In Tesla Kolin they are also pondering over streamlining the production of pressed parts from metal sheets and plates--boxes, frames, strips, etc., large quantities of which are used in electronics and which tie up a lot of manpower. They dealt with these problems at a high technical level, as one of the tasks of the state plan for technical development. At the present, research and development is coming to an end and Tesla Kolin is putting up a unique production section, so far the only one at this level in the CSSR--an integrated production sector of chipless forming machines. Production should be launched here in 1983 and solve the strained situation in this area.

Nevertheless, even in this plant they are plagued with worries and problems which they cannot solve with their own resources. In developmental efforts they are hampered, e.g., by inadequate availability of parts samples from other socialist countries and, particularly, a lack of information about their production and marketing. They also need to know what these countries will be producing in the coming years and obtain samples of parts immediately after concluded development, so that they could make use of them in the systems they themselves are developing. Our trade organizations should develop a much more flexible approach in this respect than has been the case, as what is involved is a relatively very small number of elements which, however, could bring superior results.

There are frequent discussions of the price level of the parts base and of price policy in general. High price of our parts leads to high prices of electronic systems which then lose their capability to compete on the world's markets, to include exports to the USSR.

Same as other producers of electronic systems, here too they feel the shortage of capacities in development of software for control systems. Today, with utmost exertion, they can meet only 80 percent of the tasks in this area. It is expected that help will have to be provided also by key users by providing certain capacities in their own plants. However, this process should not be interpreted as shifting the burden on the backs of the users; it is logical development brought about by utilization of advanced technology. Electronics will continue to penetrate into machining and other sectors. Under our conditions there is nobody else who can take charge of its systematic implementation other than producers--final processors.

In Tesla Kolin they are creating for them in the sector all the prerequisites for the new advanced technology to bring the expected results: a high technical level and, thus, higher export capability for the products of our industry.



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